



Responsiveness in practice: aligning nanotechnologies with societal needs and values

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Executive summary

Responsiveness is one of the major objectives of Responsible Research and Innovation (RRI), but practical realisation of the concept remains a challenge. The EU-funded GoNano project understands responsiveness as the capacity of research and innovation actors (researchers, engineers, innovators and producers) to act on societal input at a time when technological trajectories are still malleable.

The GoNano project explored the potential of co-creation as a means to enhance the responsiveness of research and innovation. By organising and analysing a series of engagement activities in the Netherlands, the Czech Republic and Spain from October 2018 to November 2019, GoNano elucidated opportunities and challenges of co-creation. The GoNano experience offers insights in the potential value of co-creation: participants valued the general opportunities for mutual learning and networking. However, getting from constructive dialogue to practical action remains a significant bottleneck. The gap between the appreciation of broader issues around research and innovation and the actual integration of those issues in daily research practices and priorities remains significant.

The GoNano experience suggests that co-creation processes need to identify the concrete interests and address the motivations of all participants, maintain continuity of thought, ‘translate’ needs and concerns from the social realm to practical options in the technological realm, and drill down to the level where the discussion topics and identified courses of action are specific enough to affect the decisions of the actors involved.

Aligning research and innovation to societal needs and values is not just a matter of deciding what sorts of future applications European citizens and stakeholders *want and need* (which is difficult enough, given widely divergent responses). It is also a matter of *practically realising* the desired change. Due to the relative autonomy of the research and innovation system, calls for responsiveness will need to identify the win-win opportunities where ‘doing good’ and ‘doing well’ coincide.

In order to enhance responsiveness throughout the research process, GoNano has formulated five rules of thumb that emerge from its co-creation experiments:

1. Nurture opportunities for mutual benefit

Opportunities for innovation that are both realistic and responsive to societal needs are rare. It takes ample time and devotion, as well as the willingness from all participants to act on them. However, this process involves trade-offs, for instance between enhancing inclusion (democratisation) and adding value in terms of concrete business optimisation.

2. Build ‘interactional expertise’ between stakeholders

“Interactional expertise” refers to the ability to converse expertly about a practical skill or expertise, but without being able to practice it, learned through linguistic socialisation among the practitioners (Collins, 2004). The development of a shared language between participants in a co-creation process allows the participants not only to recognise opportunities for building shared value, but also to identify and discuss how to actually realise that value.

3. Acknowledge the transdisciplinary, practice-oriented and iterative nature of co-creation

Co-creation is an evolving tool. It is important not only to select the appropriate stage and point in time for engagement, but also to pay attention to the suitability of the format to address specific questions in specific settings with regard to research and innovation activities.

4. Consider the benefits and drawbacks of participation for all participants

Co-creation presents opportunities and drawbacks. In fact, many ‘ordinary’, straightforward, technical problems may best be solved by traditional, monodisciplinary teams. It’s especially the ‘wicked problems’ (problems that are impossible to solve and have no single solution because of incomplete, contradictory and changing requirements that are often difficult to recognize) that require collaboration between stakeholders (Rittel and Webber, 1973). Co-creation can be an especially effective tool to tackle these types of problems. Nanotechnology governance is such a wicked problem: the challenges do not reside in the development of the technology itself, but in the required alignment between working practices, responsibilities, knowledge levels, expectations and concerns across widely divergent fields of expertise.

5. Build trust between participants

While hard to tackle, building trust between actors involved in engagement procedures to enhance responsiveness is key. It requires openness and a willingness to engage with different perspectives, as well as continuity with regard to engagement.

Introduction

Three GoNano white papers

The present publication is part of a series of three white papers developed by the GoNano project, covering different aspects of co-creation in research and innovation, with a focus on nanotechnology.

The white papers are intended as a knowledge repository for further GoNano communication activities. As such, they provide relevant background information with condensed GoNano findings. They also form the basis for six policy briefs and two industry briefs outlining the topics with policy and industry relevance.

The three GoNano white papers provide insights into different aspects of co-creation and responsiveness in the field of nanotechnologies. Each paper addresses the question of Responsible Research and Innovation (RRI) in nanotechnology research and innovation from a different angle.¹

- **White paper 1** explores the *opportunities and drawbacks of using co-creation* as a tool to enhance the responsiveness of nanotechnology research and innovation to societal needs and values. The white paper highlights the findings from the GoNano co-creation process and suggests five rules of thumb for prospective co-creation practitioners. It is mainly targeted at researchers, engineers and other stakeholders involved in research and innovation.
- **White paper 2** provides insights on *how to implement co-creation*, considering research as well as the innovation ecosystem. It addresses industrial and business partners, research institutions, and policy makers involved in research and innovation.
- **White paper 3** provides guidance on how to realise co-creation in the light of a *gender and diversity perspective* in order to better integrate these perspectives into nano-related research and innovation. The main addressees of the paper are process organisers and/or researchers in a position to put co-creation into practice.

The GoNano project: aims and findings

This white paper builds on the findings of the GoNano project, which is based on the assumption that several types of knowledge and expertise are needed to support co-creation towards sustainable, acceptable, and desirable applications of nanotechnologies. GoNano explored approaches that could be put into practice in different application areas of nanotechnologies (Health, Food and Energy), combining face-to-face citizen consultations, stakeholder workshops and online consultations (see Figure 1).

There has been growing interest in co-creation in recent years. Co-creation has been defined as the practice of collaborative product or service development, as developers and stakeholders work together; as the joint creation of value by the company and the customer; and as the co-construction of the service experience with the customer to suit their context.²

Co-creation as a method has been applied to research and innovation to achieve very different aims and objectives. Companies have used co-creation to encourage user-led innovation. Their aim is to put the needs of users at the heart of innovation. The Creator Space initiative launched by BASF, for example, aims to foster open innovation within the company.³

1. For more information on the RRI framework by the EC please see the website (<https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation>) (30-06-2020).

2. For further information see GoNano D2.1(2018), for an illustrative example, see experiences of the Fonteer project: https://www.youtube.com/watch?v=VID2EyW5W_k

3. The BASF Creator Space initiative brings together stakeholders with varying experience from within and outside of the company to develop concrete, challenge-based business outcomes. Originally developed as a one-time initiative to celebrate the 150th anniversary of BASF, the Creator Space now forms an integral part of the company's approach to innovation (in this YouTube video, Elise Kissling, Director of the Creator Space frontend innovation program at BASF, reports on Creator Space: <https://www.youtube.com/watch?v=Y0JuOWO0hB8>).

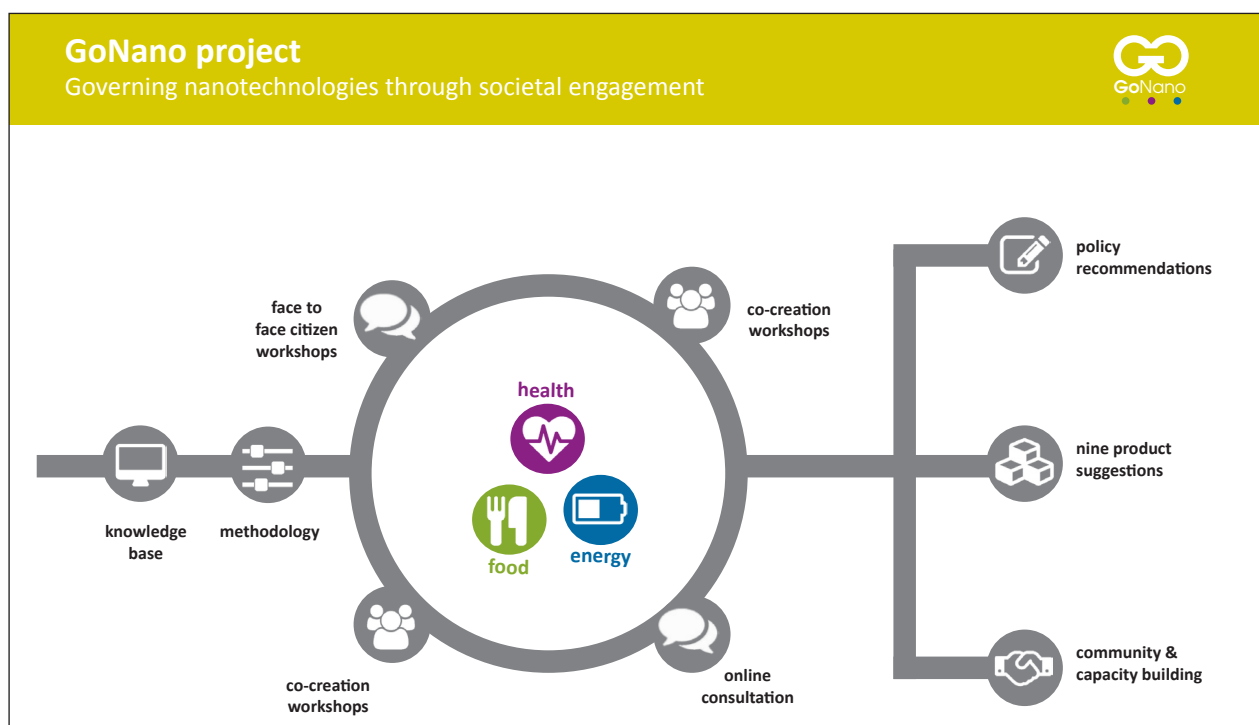


Figure 1. The GoNano co-creation process

Others have used co-creation to enable more democratic decision-making in research and innovation. The EU project Making Sense EU, for example, helped citizens to use academic technologies to make sense of their own environments.

Within the GoNano project, co-creation is applied to strengthen the ability of research and innovation processes to respond and adapt to changing demands. The underlying assumption is that research and innovation will be more socially robust if societal needs and values are considered in the early stages of innovation.⁴

GoNano defines co-creation as *“activities that enable productive collaborations between researchers and societal stakeholders over longer timeframes, focusing on specific nanotechnology research lines, leading to tangible outcomes such as a new research avenue, proposal, product or prototype”*.⁵ (GoNano D2.1, 2018)

Through the involvement of citizens and stakeholders from early stages of the innovation process, GoNano aims to make research and innovation more socially resilient.

This requires new forms of collaboration that extend across disciplines and sectors.

GoNano established an iterative, four-step co-creation process to integrate societal considerations in nanotechnologies: the first step consisted of a series of citizen workshops (one in each of the three pilot countries: the Netherlands, the Czech Republic and Spain) where citizens expressed their wishes and concerns with respect to each of the application areas (health, food and energy, respectively).⁶ In the second step, the pilot partners organised co-creation workshops

4. Using low-cost, open-source technologies, Making Sense EU empowered citizens to discuss methodologies, devise data collection strategies for measuring air pollution, water quality or sound pollution, and interpret the results. It's a win-win project: scientists can use the datasets for their research, and citizens acquire tools to understand their environment and take appropriate action. In this YouTube video Frank Kresin, Managing Director of the Design Lab at the University of Twente, highlights Making Sense EU: <https://www.youtube.com/watch?v=au3uVptWJbU>.

5. For further information, see this earlier report on the co-creation methodology for GoNano: D2.1(2018)

6. See the briefing report for further information on the outcomes of the citizen workshops (GoNano D3.2, 2019).

with stakeholders to explore ways to take the wishes and concerns of citizens into account in nanotechnology research and innovation. The results from this first stakeholder workshop were subsequently discussed in the third step of the co-creation process: an online citizen consultation to get responses from citizens from various European countries to the product suggestions of the first round of stakeholder workshops. The fourth and final step of the co-creation process consisted of a second round of stakeholder workshops organised in October and November 2019 in each of the pilot countries. These workshops explored how the product suggestions derived from the first workshops and subsequent input from the online consultation could be integrated in concrete research and innovation decisions.⁷

7. See the Final report on the insights and lessons from the engagement activities (GoNano D4.4, 2020).

Why responsiveness?

Better alignment of research processes and outcomes with the expectations, needs, and values of society continues to grow in importance in the European research and innovation policy context.

But what does this mean in practice?

- How does a research and innovation system become more responsive to societal needs and values?
- Who and what should it respond to?
- What changes to research practices does increased responsiveness require/presuppose?

The answers to these questions differ depending on one's interpretation of the term 'responsiveness'. Responsiveness can be understood as including technology assessment, research agenda-setting, etc. – all of which lead to alignment in the broad sense. This opening up of the research and innovation agenda in terms of stakeholder engagement, mutual learning and the co-development of research agendas has manifested itself in numerous approaches, ranging from participatory agenda-setting to public engagement to citizen science.

Responsiveness can also be interpreted in a more restricted, action-oriented sense, as the capacity of research and innovation actors (researchers, engineers, innovators and producers) to act on societal input at a time when technological trajectories are still malleable.

While there has been progress towards enabling responsiveness in the broader sense, e.g. with respect to stakeholder engagement and other mutual learning initiatives, there has thus far been less emphasis on responsiveness in the more action-oriented sense. Making genuine steps from reflection to action is necessary in order to sustain trust in the research and innovation system. Thus, it is important to ensure responsiveness as both a main, continuous aim and as a key outcome that is enabled by reflection throughout the whole development and innovation process.

We zoom in on the active interpretation of responsiveness here. We will consider the opportunities and obstacles that came to light in the findings of the GoNano project, which investigated the conditions for enabling responsiveness in the action-oriented sense. GoNano aims to facilitate responsiveness through co-creation, enabling citizens and professional stakeholders to become responsive to each other's needs and concerns; in other words, co-creation is seen as one possible route to enhancing responsiveness in research and innovation. While the GoNano findings as presented in this paper focus specifically on nanotechnologies, the lessons may also apply to research and innovation more broadly.

Data from the GoNano co-creation initiatives and from the literature will be mobilised in order to identify opportunities and obstacles and propose realistic paths forward for researchers required to demonstrate a responsive approach to their research. On the basis of this analysis, we will present some rules of thumb as action points through which to pursue and engender responsiveness.

Nanotechnologies and responsiveness

The drive to work closely with society has been particularly visible in the area of nanotechnologies. The fear of a social backlash against nanotechnology similar to the case of genetically modified crops in Europe has been an important driver here, with the promotion of research and innovation coupled with calls for societal engagement ever since nanotechnology started drawing attention as a field of research and economic development. The landmark UK Royal Society and Royal Academy of Engineering nanotechnology report of 2004 noted: *“As recent debates in the UK and elsewhere demonstrate, developments in science and technology do not take place in a social and ethical vacuum. Widespread discussions of issues such as nuclear energy, agricultural biotechnology and embryonic stem cells illustrate this point only too clearly.[...] Given this backdrop, it seems highly likely that some nanotechnologies will raise significant social and ethical concerns.”* (Royal Society & The Royal Academy of Engineering, 2004, p.51). The European Commission’s Strategy for Nanotechnology of 2004 stated that: *“An effective two-way dialogue is indispensable, whereby the general public’s views are taken into account and may be seen to influence decisions concerning Research and Development policy. The public trust and acceptance of nanotechnology will be crucial for its long-term development and allow us to profit from its potential benefits.”* In the US, the twenty-first century Nanotechnology Research and Development Act similarly mandated the integration of nanotechnology Research and Development with research on societal, ethical and environmental concerns (Fisher, E., & Mahajan, R. L., 2006).

The challenge as to how to integrate public voices has given rise to a steady stream of European outreach and dialogue activities over the last fifteen years or so. The European Commission’s Nanotechnologies, Advanced Materials, Biotechnology, and Advanced Manufacturing and Processing (NMBP) programme has funded a range of dedicated projects including NANODIALOGUE, NANOTOTOUCH, NANOYOU, TIMEFORNANO and SEEINGNANO. The focus of these projects was mostly on outreach, i.e. education and communication, and less focused on practically integrating societal concerns into research and innovation. More recently, projects like the NANODIODE⁸ project have begun to explore how to strengthen the responsiveness of the research and innovation system.

The question therefore remains how to enable new models of innovation that integrate societal considerations earlier and more effectively in the research and innovation process. Nanotechnology governance, including the associated public engagement landscape, is about finding the right level of public oversight needed to maximise the chances of creating maximum public benefit with acceptable levels of risk. This gives rise to some important questions: When should we actively seek to direct or control – govern – research and innovation, and when should we let the market drive innovation, and who should decide?

Nanotechnology engagement has focused on broader notions of responsiveness – and not so much the ability of innovation actors to act. This has led to calls for responsiveness in the more action-oriented sense. The Re-finding Industry report from the High-Level Strategy Group on Industrial Technologies calls for more social dialogue and participation in Europe, noting that: *“Civil society has a central role in identifying the main challenges, and must be actively involved in the development of missions and projects. The role of society in the missions and projects is not only in the execution phase, but also in most phases of the public policy cycle. Civil society must also take part in the identification of the problem itself, in setting the agenda for solutions, in the policy making and evaluation.”* (Re-Finding Industry, 2018)

The GoNano project is a recent initiative within that broader legacy. It attempts to enhance responsiveness through co-creation and thus provide a concrete way to integrate societal concerns and values into Research and Development. The following section will present the aims and activities of the project in further detail and will reflect on the preliminary findings of the project activities, noting both opportunities and obstacles.

8. For further information see: <http://www.nanodiode.eu/> (25-06-2020).

Findings from GoNano:

How can co-creation contribute to enhanced responsiveness of researchers and innovators to input from citizens and stakeholders?

The overall GoNano experience has elucidated opportunities and challenges of co-creation as a tool to enhance responsiveness of research and innovation. The findings of the GoNano co-creation process confirm that with some effort and careful preparation, it is possible to demonstrate to stakeholders that it does make sense to look at the broader dimensions of research. Indeed, the GoNano co-creation process has offered insights on the potential value of co-creation. Participants valued the general opportunities for mutual learning and networking. The GoNano co-creation process facilitated engagement between stakeholders in nanotechnologies, including citizens, researchers, engineers, producers, civil society and policy makers. The activities contributed to enhanced trust and mutual understanding between citizens and stakeholders.

For instance, a discussion between producers, policy makers, civil society, researchers and a diabetes patient around the artificial pancreas (a monitoring device for diabetes type 1 patients that continuously measures glucose levels of the patients and adds insulin and glucagon when needed) in the first stakeholder workshop on health at the University of Twente led to data management considerations that may be relevant for future data sharing agreements between the producer and users of the device. And the discussions around the Harvestore project in the second stakeholder workshop on energy in Barcelona suggested how societal considerations can be productively integrated in the development of the wireless sensor nodes. These examples suggest that 'exposure' to use considerations further down the line can attune research design to future use contexts.

The outcomes of the overall co-creation process demonstrate how bringing stakeholders with different backgrounds together may lead to relevant discussions and insights for research and product development. The relevance of this finding should not be underestimated: the productive integration of societal considerations in research and innovation will to a large extent depend on mutual learning between stakeholders, and on the shared conviction that broader societal perspectives matter. The co-creation process succeeded in addressing this vital precondition.

However, getting from constructive dialogue to practical action is a significant bottleneck. The gap between the appreciation of broader issues around research and innovation and the actual integration of those issues in daily research practices and priorities remains significant.

One of the main challenges concerns the continuity of the process, both in terms of relating the different steps of the co-creation process to each other, and in terms of between the participants of the different events. The suggestions from citizens were often formulated at a high level of abstraction: for instance, citizens emphasized the importance of values like sustainability, respect for nature and transparency as design considerations. While the participants of the stakeholder workshop acknowledged the importance of these social needs and values, it sometimes proved difficult to derive concrete design recommendations from these high-level considerations.

The findings also suggest that there is a trade-off between inclusiveness and specificity: the decision to treat all stakeholder perspectives on an equal footing for reasons of inclusiveness may come at the cost of a clear action perspective. Conversely, the choice of one particular action perspective to enable specificity is – by definition – partial and exclusive. In the first workshop on diabetes, the focus was on providing suggestions for products developed by

the businesses present at the workshop. This discussion was less relevant for some of the researchers present because they were working on research that was at an early Technology Readiness Level (TRL) and so could not be mobilised for product development.

Another trade-off that played a role throughout the design and implementation of the GoNano co-creation process concerned the simultaneous occurrence of two rationales for co-creation. The first rationale considers co-creation as a tool to ‘open up’ research trajectories, inviting multiple stakeholders who would normally not be included in research decision making, and exploring how their views might be more productively integrated in research and innovation trajectories. This rationale has its roots in movements for ‘democratization’ of science.

As such, calls for responsiveness challenge the roles and responsibilities of researchers and redefine the boundary between science and society. In a sense, RRI – and the responsiveness that it purports to advance – can be viewed as a social innovation that is ‘gradually being articulated’. (Rip, 2014)

The second rationale considers co-creation as a means to ‘add value’ to ongoing research trajectories, by inviting feedback from specific stakeholders (prospective users for example) on particular research decisions, and seeing how this feedback might improve the research outcome (by making it more efficient, cheaper, or more acceptable, for instance). While this rationale is borne from the same origins as the democratisation movement, it argues that attempts at democratisation of research and innovation have often had merely tangential effects on the governance of research. Instead, this rationale explores the possibility and utility of ‘governance from within’. (Fisher et al., 2006). Acknowledging the dominant position of technology enactors, it looks at changes in research practice that may be more modest, but can be implemented in concrete decision-making processes. On this view, ‘alignment with societal needs and values’ is interpreted more narrowly: it might include incremental changes in product design to attune the product better to consumer needs. On this approach, some idealism is forfeited for the sake of effectiveness.

To be sure, both rationales are equally valid, and both have played a role in the design of the GoNano project. The workshop outcomes suggest opportunities for both rationales as well. For instance, the consideration of the wishes, needs and messages from citizens during the first stakeholder workshop demonstrate how research trajectories can be ‘opened up’ to societal considerations. And the discussions on autonomous wireless sensor nodes for the future Internet of Things which took place during the second stakeholder workshop on energy in Spain suggests how societal considerations can add value to the development of wireless sensor nodes. However, the GoNano experience suggests that perhaps it is too much to expect both objectives to be addressed simultaneously. As D4.2, 2020 also noted, the desire to ‘add value’ to concrete research lines may come at the cost of ‘opening up’ research and innovation, and vice versa.

The GoNano experience suggests that co-creation processes need to identify the concrete interests and address the motivations of all participants, maintain continuity of thought, ‘translate’ needs and concerns from the social realm to practical options in the technological realm, and drill down to the level where the discussion topics and identified courses of action are specific enough to affect the decisions of the actors involved.

This suggests that enhancing responsiveness will depend on the function assigned to the opportunities of engagement, e.g. out of the box thinking, as well as re-orienting and potentially challenging aspects previously not considered by actors in research and innovation.



During the nanotechnology and health stakeholder workshop in Enschede (NL), one of the entrepreneurs observed that the workshop was a ‘reality-check’ of whether they were going in the right direction with their data management plan for artificial pancreas. The developer of the artificial pancreas mentioned that the co-creation workshop gave the team the possibility to explore the societal context in which their product would be implemented.

(co-creation pilot on healthcare, the Netherlands)

Nevertheless, integration may not go as smoothly as intended even when there is a willingness to consider the suggestions that have been made. During the workshops in The Netherlands and Spain, researchers and developers were motivated to look into the concerns raised by citizens or other researchers regarding data protection. However, concrete actions resulting from these good intentions will only be visible after the co-creation process when the research and/or innovation path will be developed further. That said, being responsive to societal needs also depends on emergence of opportunity, coupled with actors' ability to recognise and act on an emerging opportunity. This suggests that specific systemic conditions limit (or enhance) opportunities for responsiveness, e.g. whether or not to allow for considering wider societal values while the current system is running.

In the following section, some rules of thumb will be derived from these findings to serve as guidance in establishing and facilitating co-creation exercises. They may offer some support to those who are interested in co-creation and its role in relation to RRI.

Conclusion

GoNano elucidated opportunities and challenges of co-creation. The GoNano experience offers insights in the potential value of co-creation: participants valued the general opportunities for mutual learning and networking. However, getting from constructive dialogue to practical action remains a significant bottleneck. The gap between the appreciation of broader issues around research and innovation and the actual integration of those issues in daily research practices and priorities remains significant.

The GoNano experience suggests that co-creation processes need to identify the concrete interests and address the motivations of all participants, maintain continuity of thought, 'translate' needs and concerns from the social realm to practical options in the technological realm, and drill down to the level where the discussion topics and identified courses of action are specific enough to affect the decisions of the actors involved.

Aligning research and innovation to societal needs and values is not just a matter of deciding what sorts of future applications European citizens and stakeholders *want and need* (which is difficult enough, given widely divergent responses). It is also a matter of *practically realising* the desired change. Due to the relative autonomy of the research and innovation system, calls for responsiveness will need to identify the win-win opportunities where 'doing good' and 'doing well' coincide.

RULE OF THUMB

1

**Nurture opportunities
for mutual benefit**

WHY?

The GoNano co-creation workshops suggest that enhancing the ability of research and innovation actors to act on societal input when technological trajectories are still malleable can present significant – and often overlooked – opportunities to align research and innovation with societal needs and values. However, this comes at a price. Responsiveness is at odds with inclusiveness: enabling research and innovation actors to revise research decisions due to societal considerations is necessarily exclusive.

Opportunities for innovation that are both realistic and responsive to societal needs are rare. It takes ample time and devotion, as well as the willingness from all participants to act on them. However, this process involves trade-offs, for instance between enhancing inclusion (democratisation) and adding value in terms of concrete business optimisation.

HOW?

Our experience from previous projects (NanoDiode, RRI-Practice, and others) and the findings of the academic literature (Fisher and Rip, 2013; Owen et al., 2012; Stilgoe et al., 2012) show that a system's ability to respond and adapt to changing conditions depends on several factors. A key factor for change is the emergence of opportunity, coupled with actors' ability to recognise and act on an emerging opportunity. Especially aligning research and innovation to societal needs and values is not just a matter of deciding what sorts of future applications European citizens and stakeholders want and need (which is difficult enough, given widely divergent responses). It is also a matter of practically realising the desired change.

Another important overall conclusion is that the implementation of a co-creation process that identifies and realises concrete steps towards more socially robust research and innovation requires considerable resources. Co-creation processes need to identify the concrete interests and address the motivations of all participants, maintain continuity of thought, 'translate' needs and concerns from the social realm to practical options in the technological realm in real time, and drill down to the level where the discussion topics and identified courses of action are specific enough to affect the decisions of the actors involved.

The GoNano pilots involved multiple stakeholders with the potential to act as change agents in the nanotechnology research and innovation system. They included nanotechnology researchers, industry and innovation network representatives, civil society organisation representatives, citizens and policy makers. Where one stakeholder group sees a challenge, another may see an opportunity; however, simply throwing these diverse groups together does not guarantee a positive outcome – much work must be done in advance to ensure smooth interactions and support the stakeholders' abilities to recognise the opportunities provided through collaborative work modes such as interdisciplinary work and cross-sectoral approaches. The GoNano co-creation process was designed to include multiple steps with structured and unstructured interactions between stakeholders to maximize the potential for identifying opportunities in nanotechnology research (also see the GoNano Toolkit for Research and Engineers).⁹

9. <http://gonano-project.eu/toolkit-for-researchers-and-engineers> (16-06-2020)

RULE OF THUMB

2

**‘Interactional expertise’
between stakeholders**

WHY?

“Interactional expertise” refers to the ability to converse expertly about a practical skill or expertise, but without being able to practice it, learned through linguistic socialisation among the practitioners (Collins, 2004). The development of a shared language between participants in a co-creation process allows the participants not only to recognise opportunities for building shared value, but also to identify and discuss how to realise that value.

HOW

The purpose of the co-creation event prescribes the actors that should be involved and the ways in which they contribute. When the purpose of the co-creation event leans more towards opening-up research and innovation, the aim is to have a creative brainstorm session about possible future applications of nanotechnology. Brainstorming benefits from diversity and equality of the contributors. The more diverse the composition of the group and the wilder the ideas, the more productive the brainstorm session will have been. A shared language allows each participant to meaningfully discuss the ‘value’ of their contribution with the other participants. The ‘symmetry of ignorance’ is a key principle here: this means that we are all expert in some fields, but laypersons in most others.

In other cases, when aiming to add value to ongoing research trajectories for example, detailed understanding of the research choices that are available (hence of the research at hand) is necessary. This means that only those who, at the very least, have interactional expertise can meaningfully participate in these collaborations. In this example, only certain considerations can be operationalised, i.e. those that can be operationalised at the level of research decisions. In other words, certain things need to be taken for granted (e.g. it does not make sense at this level to conclude that the type of research at hand should not be carried out at all. While this could be a legitimate conclusion, it moves the debate into the policy arena).

RULE OF THUMB

3

**Acknowledge the
transdisciplinary,
practice-oriented
and iterative nature
of co-creation**

WHY

Co-creation is an evolving tool. It is important not only to select the appropriate stage and point in time for engagement, but also to pay attention to the suitability of the format to address specific questions in specific settings with regard to research and innovation activities.

HOW

By understanding the potential and limitations of distinct forms of engagement; targeting them to the appropriate stage in the innovation process; and adjusting the nature of the engagement measures to the specific actors, while being aware of the opportunities and challenges of each form of engagement.

GoNano demonstrated that the purpose of the co-creation event prescribes the co-creation approach, goal and tools. For instance, citizen and multi-actor consultations could help to determine the sorts of research that we – as a society – do or do not want to pursue, and the ways in which we do or do not want nanotechnology to shape our society. GoNano used future scenarios of future nanotechnology application to help visualise future products of nanotechnology, and raise questions on acceptability, sustainability and desirability.

More focused and in-depth co-creation approaches can be used to integrate specific societal considerations into concrete research trajectories. In order to achieve such in-depth approaches, GoNano structured the workshops around four interrelated co-creation sessions: exploration, ideation, prototyping and reflection. Each step had its own purpose (such as getting to know each other needs and wishes in the exploration phase or having a more focussed discussion and trying to generate a concrete suggestion for research lines or product innovations). It is also important to consider the different roles of various stakeholders at every step of the value chain. Creating a stakeholder map can contribute to the ex ante definition of the kind of interaction required from the specific actor group (e.g. listen, decide, provide knowledge, and so on) and at which step of the value chain this interaction should take place (see white paper 2).

RULE OF THUMB

4

**Consider the benefits
and drawbacks of
participation for all
participants**

WHY

Co-creation presents opportunities and drawbacks. In fact, many ‘ordinary’, straightforward, technical problems may best be solved by traditional, monodisciplinary teams. It’s especially the ‘wicked problems’ (problems that are impossible to solve and have no single solution because of incomplete, contradictory and changing requirements that are often difficult to recognize) that require collaboration between stakeholders (Rittel and Webber, 1973). Co-creation can be an especially effective tool to tackle these types of problems. Nanotechnology governance is such a wicked problem: the challenges do not reside in the development of the technology itself, but in the required alignment between working practices, responsibilities, knowledge levels, expectations and concerns across widely divergent fields of expertise.

The question of ‘What’s in it for me?’ is a question that each participant will ask herself. Stakeholders must see this added value in the interaction in relation to their individual goals and objectives themselves. Researchers, for example, do not see stakeholder involvement as core business. It will only become core business for them if enactors see the added value of these interactions in relation to their own goals and objectives. This requires compelling examples that demonstrate how the research improved or how resistance was overcome. The FoTRRIS project¹⁰ found that a positive correlation can be seen between the relevance of cooperation for a particular research field and the willingness of research and innovation actors to engage in collaboration. Thus, drivers for involvement in a co-creation project should be carefully considered. For example, academics may seek to move closer to industrial contexts by improving the industrial relevance of their training programmes and ensuring the societal relevance of their research programmes.

Moreover, close collaboration with non-research actors should not put the research and innovation community’s autonomy and independence at risk. If we want to engage researchers, it is our responsibility to demonstrate that it does make sense to look at the broader dimensions: this can be achieved by highlighting that such reflection can help researchers to achieve their own goals (this is first-order learning). In order to achieve this, social sciences and humanities communities need to strengthen their consultancy skills and their ability to understand the context and ‘DNA’ of the actors involved:

- from product-driven (‘Here’s my theory, what do you think?’) to demand-driven: ‘How can I help you?’
- clear and compelling examples, presented in a way that non-experts can understand

HOW

As co-creation comes in many shapes and sizes, each type of co-creation involves different types of actors, with different expected outputs in different stages of innovation. The purpose of the event prescribes the actors that should be involved and the ways in which they contribute. Seeking a shared goal that drives collaboration between stakeholders is key: all participants need to be intrinsically motivated in order to get involved and remain involved. This might involve mobilisation around a specific problem that requires a need for consensus, e.g. how can we move forward in tackling this problem? Going back to the example in the why section above, researchers and developers will need to know why, to what end, and when they need input from stakeholders.

Defining what is at stake is crucial. In other words, it is necessary to have a clear problem diagnosis, e.g. exploring norms and values related to the technology at stake, the potential contributions of citizens to the research process and, especially in the case of nanotechnology, the degree of urgency and openness with regard to research activities. In short, expectation management on different levels is key.

Focussing on researchers specifically, in order to motivate scientists to participate in and engage with co-creation exercises, it may be helpful to find individuals within the scientific community who want to do something that may not be immediately useful to their own research, i.e. those scientists who are not continuously concerned about ‘What’s in it?’ for them. Ideally, co-creation projects like GoNano would work with scientists and researchers who are interested in collaboration whether it serves their own purposes or not and who find during the collaboration that it is actually relevant to their work.

10. <http://fotrris-h2020.eu/> (25-06-2020)

RULE OF THUMB

5

**Build trust between
participants**

WHY

Close collaboration as required by co-creation is far from being a mainstream procedure; this means it is crucial to establish trust in both people and organisations as well as in the co-creation process itself. People have to be open and willing to see the ‘win-win’ of co-creation and to trust each other and their respective roles in the process. A partnership has to be allowed to develop; this might be related to opening up research and innovation (claim to more and broader inclusion) or adding value (claim to improve specific products). Co-creation work will take on varying degrees of importance and meaning according to the type of stakeholder involved.

HOW

Establish a culture of thorough argumentation: whoever participates and shares their knowledge (regardless of expert knowledge or lay knowledge) needs to know that they are being listened to, that they have a say, and how their input will be further processed (communication and transparency). Since co-creation events often involves collaboration between individuals with very different backgrounds. To build trust and work together effectively, participants have to learn where the others are coming from and what they would like to achieve. By building a shared language, it allows each participant to meaningfully discuss the ‘value’ of their contribution with the other participants. Building shared understanding between participants also implies that clear ground rules for discussion should be in place: everyone should be allowed to speak; participants should actively listen to what the others have to say; they treat each other as equals; they explore what new and crazy ideas might contribute to the overall aim, rather than simply dismissing them; differences in opinion are valued, not suppressed.

This, however, should not stop at the level of individual co-creation or engagement processes, but extend to the policy arena: Why and how are inputs, thoughts and reflections there included or excluded? Keep participants informed about the outcomes of the project and build a community of interested people. This also makes it easier to disseminate results after the project and to ensure that other people get to know about the project.

References

- Collins, H. (2004). Interactional expertise as a third kind of knowledge. *Phenomenology and the Cognitive Sciences* 3, 125–143. <https://doi.org/10.1023/B:PHEN.0000040824.89221.1a>
- European Commission. (2007). Work programme 2007, Capacities, Part 5, Science in Society. C(2007)563.
- European Commission. (2019) Implementing RRI in Horizon 2020. Available from: <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation>. (Accessed December 2019).
- Fisher, E., Mahajan, R.L. and Mitcham, C. (2006) Midstream Modulation of Technology: Governance From Within. *Bulletin of Science Technology & Society* 26(6):485-496. 10.1177/0270467606295402.
- Fisher, E., and Mahajan, R. L. (2006). Contradictory intent? US federal legislation on integrating societal concerns into nanotechnology research and development. *Science and Public Policy*. 33(1):5–16
- Fisher, E., and Rip, A. (2013). Responsible innovation: Multi-level dynamics and soft intervention practices. In R. Owen, J. Bessant, & M. Heintz (Eds.), *Responsible innovation: Managing the responsible emergence of science and innovation in society* (pp. 51–74). London: Wiley.
- GoNano D1.1 (2018) Deliverable 1.1: Building on the state-of-the-art: ex-post evaluation on mutual learning. Brussels: GoNano project.
- GoNano D2.1. (2018). Deliverable 2.1: Method and manuals for the pilot studies: towards a GoNano co-creation approach. Brussels: GoNano project.
- GoNano D3.2. (2019). Deliverable 3.2: Citizen needs and values in relation to nanotechnology in food, energy and health: A report from citizen workshops in the Czech Republic, Spain and the Netherlands. Brussels: GoNano project.
- GoNano D4.2. (2019). Deliverable 4.2: Working paper on the designs and outcomes of workshop round 1. Brussels: GoNano project.
- GoNano D4.4 (2020) Deliverable 4.4: Final report on the insights and lessons from the engagement activities. Brussels: GoNano project.
- Owen, R., Macnaghten, P. and Stilgoe, J. (2012). Responsible research and innovation: From science in society, to science for society, with society. *Science and Public Policy*, 39, 751–760.
- Re-Finding Industry. Report from the High-Level Strategy Group on Industrial Technologies. European Commission, 2018.
- Rip, A. (2014). The past and future of RRI. *Life Sciences, Society and Policy*, 10(17), 1–15.
- Rittel, H.W. J. & M.M. Webber. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences* 4: 155–169.
- Royal Society & The Royal Academy of Engineering. (2004). *Nanoscience and nanotechnologies: Opportunities and uncertainties*. London: Royal Society.
- Schuurbiers, D. and Fisher, E., 2009. Lab-scale intervention. *EMBO reports*, 10(5), pp.424-427.
- Stilgoe, J., Owen, R., and Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy*, 42(9), 1568-1580



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